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DRAWINGS ATTACHED

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(54) FIBROUS SHEET AND METHOD OF PRODUCING SAME

(71) We, PAPER CONVERTING MACHINE COMPANY, INC., a Corporation organized and existing under the Laws of the State of Wisconsin, United States of America, of 2300 South Ashland Avenue, Green Bay, Wisconsin, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

For years, those in the art of clothing, for example, have sought to provide paper substitutes for textiles. One drawback of any paper garment is its lack of strength. When this has been sought to be remedied by treating the paper with stiffening materials or moisture-proofing agents, there has resulted an uncomfortable product; no satisfactory cloth substitute has been found which "breathes", viz., is fluid permeable.

According to the present invention there is provided a method of producing a fibrous sheet, which comprises uniting two flexible fibrous webs with an intervening heat-shrinkable flexible thermoplastic web along a plurality of lines to form a plurality of unbonded areas each having lines of union as at least a partial boundary thereof, heating the web assembly to induce heat shrinkage of the thermoplastic web whereby to cause the unbonded areas of the thermoplastic web between adjacent lines of union to become thicker than the thermoplastic web at the lines of union and to cause the unbonded areas of the fibrous webs to bulge into pillow-like contours, and controlling the conditions of heating as to time, temperature, pressure and tension whereby to selectively develop minute openings of the order of 0.001" to 0.002" diameter in said thermoplastic web adjacent said lines whereby the permeability of said web assembly is controllable.

The lines of union may be either straight or curved, yielding unbonded areas perimetrically bounded by the lines and ranging in shape from square or diamond shapes to circular shapes, but also including forms where only a part of the area is so bounded, as with parallel straight or curved lines of union.

The flexible fibrous webs may take a variety of forms, including paper webs in the nature of tissue, and non-woven webs made from fibres such as viscose rayon.

The flexible thermoplastic web likewise may be provided in a variety of forms, optimally being a heat-shrinkable film of a thickness from 1/4 mil to 2 mils in thickness (one mil equals 0.001"). Exemplary of such films are polyethylene and polypropylene, although other flexible webs having the capability of shrinking under heat are employable. At present, the most economically feasible assembly has at least one of the fibrous webs made of tissue and the thermoplastic web of polyethylene.

The method may be practised with fibrous webs, one or each of which is embossed prior to uniting with the thermoplastic web.

Through the practice of the present invenhion we are able to selectively develop minute openings in the thermoplastic web adjacent the lines of union which permit the web assembly to "breathe", viz., be fluid permeable, and thus we are able to provide a "breathable" fibrous sheet useful in place of textile or plain fibrous sheets and advantageous for making articles from it which are "disposable" in the sense, of being designed to be thrown away after use, and suitable for a variety of uses such as clothing, bedding, mechandising and construction, in each case being able to control the permeability of the sheet to a desired value.

The invention is described in conjunction with the accompanying drawings in which:

FIG. 1 is a side elevational view, partially

schematic, of apparatus for practising the invention;

FIG. 2 is a fragmentary perspective view, partially in section, of a web assembly at an intermediate stage of production on the apparatus of FIG. 1;

FIG. 3 is an enlarged fragmentary sectional view taken along the line 3—3 of FIG. 2;

FIGS. 4 and 5 are views similar to FIG. 3, but of the web assembly at later intermediate stages in production;

FIG. 6 is a view similar to FIG. 5, being of a completed web assembly; and

FIG. 7 is a fragmentary sectional view as seen along the line 7—7 of FIG. 6.

In practice of the invention, the apparatus depicted in FIG. 1 may be employed using as sources of material unwind stands as at 10, 11, and 12. The unwind stands 10 and 12 are equipped with rolls 13 and 14 of tissue or like flexible fibrous web, whereas the unwind stand 11 is equipped with a roll 15 of heat-shrinkable flexible thermoplastic material such as 1/2 mil polyethylene. The webs developed from the unwind stands 10—12 are designated 16, 17 and 18 respectively, and it will be seen that the web 18 is delivered to an embossing unit 19 having suitable embossing rolls 20 and 21. The web 16 is delivered to a second embossing unit 22 which is equipped with suitable embossing rolls 23 and 24. The intermediate thermoplastic web 17 is conducted over various idler rolls, as at 25, so as to be positioned against the web 18 when passing over the idler roll 26 and in contact with the web 16 when passing over the idler roll 27.

The three webs are united by means of a lamination unit generally designated 28, and which includes a rotating drum 29 carried in suitable bearings (not shown) on a frame 30. Urging the plurality of webs against the surface of the heated drum 29 is an endless belt 31 arranged to travel over a plurality of rolls also journaled within the frame 30. The surface of the drum 29 is equipped with suitable union-producing areas, hereinbefore referred to as lines. For example, in the product illustrated in FIG. 2, it will be noted that the three webs 16—18 are united along a plurality of spaced apart intersecting lines, as at 32, 33, 34, etc., in one direction, and 35, 36, 37, etc. in the direction perpendicular to the lines 32—34. Each line of union or seal may be advantageously, as in the illustration given, of a width of the order of about 1/16" so as to develop diamond-shaped areas 1/2" on a side. Thus, raised portions of a character suitable to develop such a pattern are provided on the surface of the laminating drum 29.

Following the uniting of the various webs, the now laminated web assembly 38 is conducted over various idler rolls, as at 39, 40 and 41, to a heating unit generally designated 42. Interposed in the path of travel of the web 38 between the rolls 40 and 41 is a tension control roll schematically represented as at 43. In the heating unit, the web passes over a series of heating rolls as at 44, 45, and 46, and thence over a series of cooling rolls as at 47, 48, and 49. The direction of the web 38 as it is about to issue from the heating unit 42 is controlled by an idler roll 50, and further idler rolls 51 and 52. Another tension control roll 53 is provided for the web between the rolls 51 and 52.

The surface speed of the heating and cooling rolls is independently controlled to compensate for the various amounts of shrinkage in the web which is introduced due to the heating and cooling. This heating and cooling may also be accomplished by passing the web through an oven and cooling chamber or also by passing the web over stationary heating and cooling plates.

Completion of the operation is achieved relative to the web 38' (see the extreme right hand portion of FIG. 1) as it passes around idler rolls 54 and 55 into a rewind mechanism generally designated 56.

Referring now to FIG. 4, the web assembly 38 is seen in the form it exists in leaving the laminating unit 28. The line of union 34 is seen to include portions of the three webs 16—18 and wherein the fibrous webs 16—18 are united by partial flow of the thermoplastic material making up the web 17. As the web 38 passes through the heating unit 42, the thermoplastic portion of the web assembly shrinks and becomes thicker between adjacent lines of union as at 17' in FIG. 5 (compare the dotted line showing designated 17 referring to the original thickness of the thermoplastic film 17). The heating induces the shrinkage which, in one illustrative embodiment of the invention, increases the thickness of the film 17 from 1/2 mil (0.0005") to 3/4 mil (0.00075"). Additionally, the shrinkage causes the fibrous webs to bulge in pillow-like contours as at 16' and 18'. Here, it should be appreciated, that the showings in FIG. 4 and FIG. 5 are exaggerated in order to facilitate understanding of the invention. However, shrinkages of the order of 10—30% in the film 17 are achievable, and this necessarily results in a substantial pillowing effect on the fibrous webs 16 and 18, as represented at 16' and 18' in FIG. 5.

In addition to shrinking the thermoplastic portion, the amount of heating that is performed on the web 38 results in the web 38'' is seen in FIG. 6 and FIG. 7. There, the thermoplastic web 17'' is seen to have a number of perforations or minute openings as at 57.

Although the mechanism by which this phase of the invention operates is imperfectly

understood, it is believed that along the lines of union (as at 34) the fiber webs 16 and 18 are embedded or intermixed with the thermoplastic web 17. Alongside the seal (immediately adjacent the linear unions 32—37) the webs 16 and 18 are still fibrous and fluffy and form an insulating wall which somewhat protects the thermoplastic film 17 where it is not sealed. Therefore, the thermoplastic film 17 in the area of the unions 32—37 become hotter, and when shrinkage takes place the edge along the seal is actually melted somewhat, resulting in small ruptures or holes (as at 57) when the unsealed thermoplastic web 17 begins to shrink. Examination of the openings 57 reveals that in certain instances these are elongated in a direction perpendicular to the length of the adjacent lines of union 32—37. These openings have an effective diameter of the order of 0.001" to 0.0002", the magnitude of the openings and the number of openings depending upon the lamination pattern and the degree of heating, i.e., being dependent upon the time, temperature, and pressure or tension employed. We have found that we can duplicate the opening producing effect of the heating unit 42 by making use of metal plates in a static operation heated to 300°F. and exposing the web assembly 38 thereto for one second.

Optimally, the invention is practiced with embossed webs 16 and 18, although this effect is dispensable in certain operations. Advantageously, the embossment is developed through the use of embossing rolls having from 10 to 200 protuberances per square inch, with each of a height of the order of 0.01—0.005", so that 10 to 75% of the total area of the web is embossed, a suitable sheet for the webs 16 and 18 having a ream weight (per 3,000 square feet) of from eight to fifty pounds. The embossed web can be clearly seen, as at 16 and 18, relative to the web assembly 38' in FIG. 3.

WHAT WE CLAIM IS:—

1. A method of producing a fibrous sheet, which comprises uniting two flexible fibrous webs with an intervening heat-shrinkage flexible thermoplastic web along a plurality of lines to form a plurality of unbonded areas each having lines of union as at least a partial boundary thereof, heating the web assembly to induce heat shrinkage of the thermoplastic web whereby to cause the unbonded areas of the thermoplastic web between adjacent lines of union to become thicker than the thermoplastic web at the lines of union and to cause the unbonded areas of the fibrous webs to bulge into pillow-like contours, and controlling the conditions of heating as to time, temperature, pressure and tension whereby to selectively develop minute openings of the order of 0.001" to 0.0002" diameter in said thermoplastic web adjacent said lines whereby the permeability of said web assembly is controllable.

2. A method in accordance with claim 1 in which said lines constitute the perimeter of said areas.

3. A method in accordance with claim 1 or 2 in which at least one of the fibrous webs is of tissue and the thermoplastic web is of polyethylene.

4. A method in accordance with claim 1, 2 or 3 in which one or each of said fibrous webs is embossed prior to uniting with the flexible thermoplastic web.

5. A fibrous sheet comprising two flexible fibrous webs arranged in face-to-face relation with a flexible thermoplastic web therebetween, lines of union joining said webs together to provide a plurality of unbonded areas each having said lines of union as at least a partial boundary thereof, the unbonded areas of said thermoplastic web between adjacent lines of union having a greater thickness than that of said thermoplastic web at the lines of union and said thermoplastic web having minute openings of the order of 0.001" to 0.0002" diameter therein adjacent the lines of union, and said fibrous webs bulging in pillow-like contours between adjacent lines of union.

6. A fibrous sheet in accordance with claim 5 in which at least one of said flexible fibrous webs is embossed with protuberances each having a height of the order of 0.01" to 0.05" with from ten to two hundred protuberances per square inch of web surface.

7. A method of producing a fibrous sheet substantially as hereinbefore described with reference to the accompanying drawings.

8. A fibrous sheet made according to the method hereinbefore described with reference to the accompanying drawings.

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1276228 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale

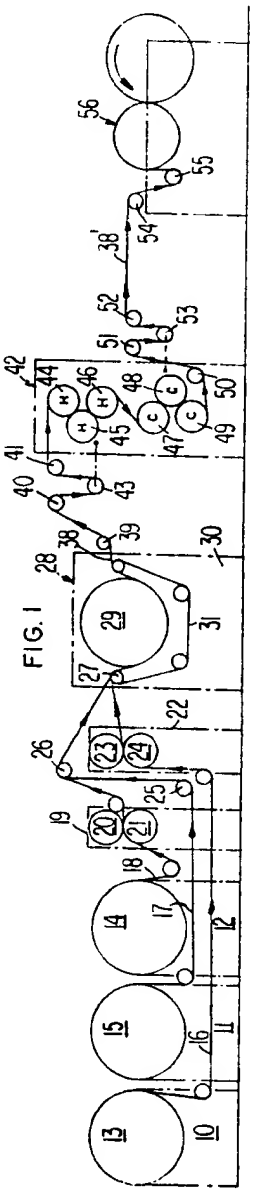

FIG. 1

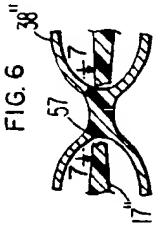

FIG. 6

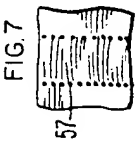

FIG. 7

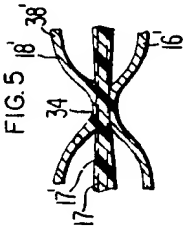

FIG. 5

FIG. 3

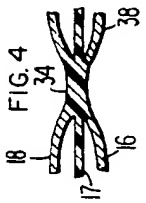

FIG. 4

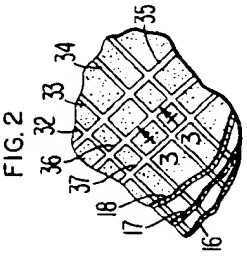

FIG. 2